

CLAIMS

We claim:

1. A sulfur scavenging composition comprising a diamine terminated reaction product of at least one aldehyde with at least one primary amine, where the reaction product includes substantially bimolecular amine-aldehyde adducts.

2. The composition of claim 1, wherein the composition includes a sufficient amount of the diamine to substantially eliminate aldehyde liberation upon heating.

3. The composition of claim 1, wherein the reaction product is substantially free of higher aldehyde-amine adducts.

4. The composition of claim 3, wherein the higher aldehyde-amine adducts are selected from the dimers, trimers, triazines and mixtures thereof.

5. The composition of claim 1, wherein the primary amines are selected from the group consisting of amines of the general formula:



where R'' is a linear or branched alkyl, aryl, alkaryl, or aralkyl group having between about 1 and about 20 carbon atoms and where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties and/or nitrogen atoms can be in the form of tertiary amine or amide moieties, and one or more of the hydrogen atoms can be replaced by a fluorine atom or chlorine atom.

6. The composition of claim 1, wherein the aldehydes are selected from the group consisting of aldehydes of the general formula:



or aldehyde donors that generate such aldehydes, where R' is a hydrogen atom (H) or a linear or branched alkyl, aryl, alkaryl, or aralkyl group having between about 1 and about 20 carbon atoms and where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy

and/or ether moieties and/or nitrogen atoms can be in the form of tertiary amine or amide moieties, and where one or more of the hydrogen atoms can be replaced by fluorine atoms and/or chlorine atoms.

7. The composition of claim 1, wherein the aldehydes are selected from the group consisting of the general formula:



or aldehyde donors that generate such aldehydes, where R' is selected from the group consisting of H, methyl, ethyl, propyl, isopropyl, butyl, sec-butyl, isobutyl, hexyls (linear or branched), heptyls, octyls, nonyls, decyls, phenyl, benzyl, methyl substituted phenyls, and mixtures or combinations thereof.

8. The composition of claim 1, wherein the aldehydes are selected from the group consisting of formaldehyde, paraformaldehyde, arylaldehydes, methoxyaldehydes, hydroxyaldehydes or aldols, glyceraldehydes, vanillin, veratraldehyde, alloxan, nonal, 1-formyl piperidine, salicylaldehyde, citronella and mixtures or combinations thereof.

9. The composition of claim 1, wherein the aldehydes are selected from the group consisting of paraformaldehyde, paraldehyde, formaldehyde, acetaldehyde, glycolaldehyde, glyceraldehyde, hydroxymethyl glyceraldehyde, glyoxal, and methyl formcel (a hemi-acetal, 55 percent formaldehyde solution in methanol and methoxy-methanol or water), aldols, and mixtures or combinations thereof.

10. The composition of claim 1, wherein the diamines are selected from the group consisting of diamines of the general formula

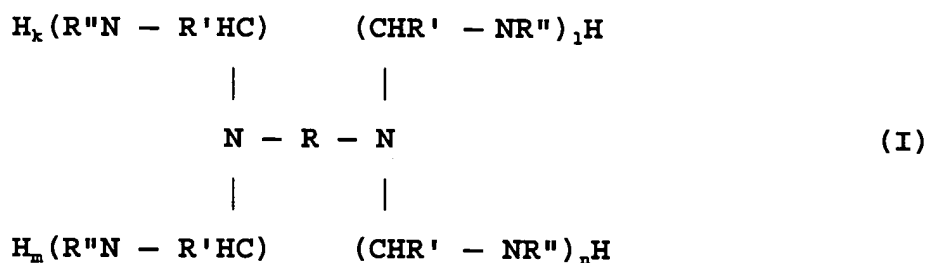


where R is linear or branched alkenyl groups having between about 1 and about 20 carbon atoms, cycloalkenyl groups having between about 1 and about 20 carbon atoms, alkylcycloalkenyl groups having between about 1 and about 20 carbon atoms, alkylarenyl group having between about 1 and about 20 carbon atoms, arylalkenyl group having between about 1 and about 20 carbon atoms and mixtures or combinations thereof, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties and/or nitrogen atoms can be in the form of

tertiary amine or amide moieties, and where one or more of the hydrogen atoms can be replaced by fluorine atoms and/or chlorine atoms.

11. The composition of claim 1, wherein the primary amine is methyl amine, the aldehyde is formaldehyde and the diamine is amine heads.

12. A composition for converting noxious sulfur species to high molecular weight sulfur species comprising at least one compound of formula (I):



where R is an alkenyl group, cycloalkenyl or arenyl group having between about 1 and about 20 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties and/or nitrogen atoms can be in the form of tertiary amine or amide moieties, R' and R'' are the same or different carbon-containing groups having between about 1 and about 20 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties or nitrogen atoms in the form of tertiary amine and/or nitrogen-containing groups in the form of amide moieties and where k, l, m and n are integers having a value between 0 and 2, provided that at least one has a value of 1 or 2.

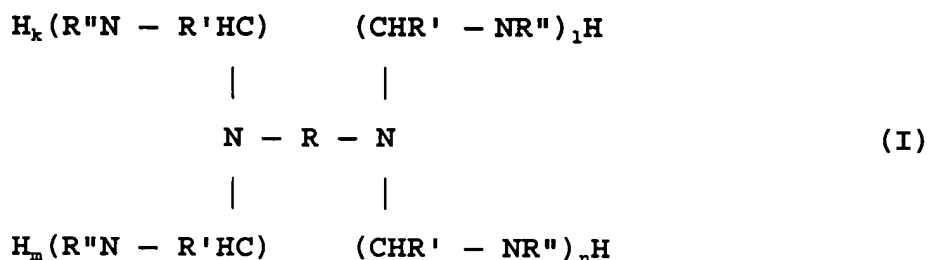
13. The composition of claim 12, wherein the composition includes a sufficient amount of the diamine to substantially eliminate the liberation of aldehyde upon heating and where the reaction product includes substantially no higher aldehyde-amine adducts.

14. The composition of claim 12, wherein R'' is a methyl group, R' is H, and R is an cycloalkenyl group associated with diamines in amine heads.

15. A method for preparing sulfur scavenging compositions including the steps of:
contacting at least one aldehyde with at least one primary amine under conditions to form a

3 reaction product comprising substantially bimolecular adducts of the amines and the aldehydes
4 having substantially no trimer or triazine adducts; and

5 contacting the reaction product with at least one diamine to form a final reaction product
6 comprising at least one compound of formula (I):



7 where R is an alkenyl group, cycloalkenyl or arenyl group having between about 1 and about 20
8 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy,
9 hydroxy, and/or ether moieties and/or nitrogen atoms in the form of tertiary amine and/or amide
10 moieties, R' and R'' are the same or different carbon-containing groups having between about 1 and
11 about 20 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of
12 carboxy, hydroxy and/or ether moieties or nitrogen atoms in the form of tertiary amine and/or
13 nitrogen-containing groups in the form of amide moieties and where k, l, m and n are integers having
14 a value between 0 and 2, provided that at least one has a value of 1 or 2.

1 16. The method of claim 15, wherein the diamine is added in an amount sufficient to
2 substantially eliminate aldehyde liberation upon heating.

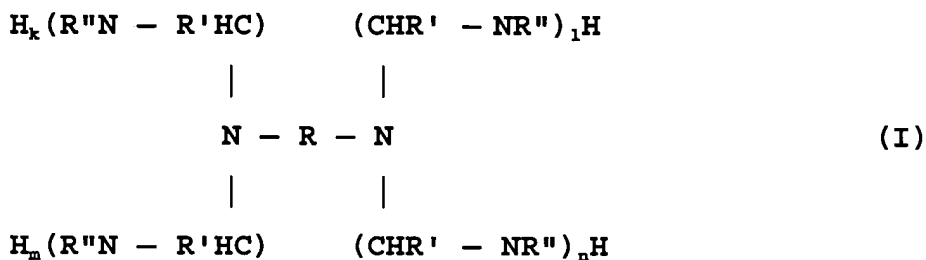
1 17. The method of claim 15, further comprising the step of:
2 contacting the final reaction product with a reducing agent to convert any imine by-products
3 in the final reaction product to their corresponding saturated analogs.

1 18. The method of claim 17, wherein the reducing agent is sodium borohydride.

1 19. The method of claim 15, wherein R'' is a methyl group, R' is H, and R is an cycloalkenyl
2 group associated with diamines in amine heads.

1 20. A method comprising the step of:

2 contacting a fluid or fluid stream including noxious sulfur species with an effective amount
3 of a sulfur scavenging or converting composition including a compound of formula (I):



4 where R is an alkenyl group having between about 1 and about 20 carbon atoms, where one or more
5 of the carbon atoms can be oxygen atoms in the form of ether, hydroxy or carboxy moieties and/or
6 nitrogen atoms in the form of tertiary amine or amide moieties or amide moieties, R' and R'' are the
7 same or different carbon-containing groups having between about 1 and about 20 carbon atoms,
8 where one or more of the carbon atoms can be oxygen atoms in the form of ether, hydroxy or
9 carboxy moieties and/or nitrogen atoms in the form of tertiary amine moieties or amide moieties,
10 where k, l, m and n are integers having a value between 0 and 2, provided that at least one has a
11 value of 1 or 2, where the composition does not liberate aldehyde upon heating and includes no or
12 only trace amounts of triazines, and where the amount is sufficient to reduce, to reduce below a
13 target level or to substantially eliminate the noxious sulfur species.

1 21. The method of claim 20, wherein the composition includes a sufficient amount of diamine
2 to substantially eliminate aldehyde liberation upon heating.

1 22. The method of claim 21, wherein the sulfur scavenging or converting composition further
2 comprising a solvent.

1 23. The method of claim 20, further comprising the step of:
2 injecting the composition into a well via capillary coiled tubing.

1 24. The method of claim 20, further comprising the step of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater
3 than or equal to about 1.5 times the measured level of noxious sulfur species.

1 25. The method of claim 20, further comprising the step of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater
3 than or equal to about 2 times the measured level of noxious sulfur species; and
4 reducing the amount of the composition until the measured amount of noxious sulfur species
5 it below a target value.

1 26. The method of claim 20, wherein R" is a methyl group, R' is H, and R is an cycloalkenyl
2 group associated with diamines in amine heads.

1 27. A method comprising the step of:
2 injecting, into a fluid or fluid stream including noxious sulfur species, an effective amount
3 of a sulfur scavenging or converting composition comprising a diamine terminated reaction product
4 of at least one aldehyde with at least one primary amine, where the reaction product includes
5 substantially bimolecular amine-aldehyde adducts.

1 28. The method of claim 27, wherein the composition includes a sufficient amount of diamine
2 to substantially eliminate aldehyde liberation upon heating.

1 29. The method of claim 28, wherein the sulfur scavenging or converting composition further
2 comprising a solvent.

1 30. The method of claim 27, wherein the injecting step includes atomizing the composition
2 during injection.

1 31. The method of claim 27, further comprising the steps of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater
3 than or equal to about 1.5 times the measured level of noxious sulfur species.

1 32. The method of claim 27, further comprising the steps of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater

3 than or equal to about 2 times the measured level of noxious sulfur species, and
4 reducing the amount of the injected composition until the measured amount of noxious sulfur
5 species it below a target value.

1 33. The method of claim 27, wherein R" is a methyl group, R' is H, and R is an cycloalkenyl
2 group associated with diamines in amine heads.

1 34. A method comprising the step of:
2 injecting an effective amount of a sulfur scavenging or converting composition comprising
3 a diamine terminated reaction product of at least one aldehyde with at least one primary amine,
4 where the reaction product includes substantially bimolecular amine-aldehyde adducts into fluids
5 in an oil or gas well via capillary coiled tubing.

1 35. The method of claim 34, wherein the composition includes a sufficient amount of diamine
2 to substantially eliminate aldehyde liberation upon heating.

1 36. The method of claim 35, wherein the sulfur scavenging or converting composition further
2 comprising a solvent.

1 37. The method of claim 34, further comprising the steps of:
2 injecting the effective amount of the composition at multiple points down a depth of the well.

1 38. The method of claim 34, further comprising the steps of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater
3 than or equal to about 1.5 times the measured level of noxious sulfur species.

1 39. The method of claim 34, further comprising the steps of:
2 measuring a level of noxious sulfur species in the fluid, where the effective amount is greater
3 than or equal to about 2.0 times the measured level of noxious sulfur species, and
4 reducing the amount of the injected composition until the measured amount of noxious sulfur
5 species it below a target value.

1 40. A method comprising the step of:

2 treating a fluid or fluid stream including noxious sulfur species with an effective amount of
3 a sulfur scavenging or converting composition comprising a diamine terminated reaction product of
4 at least one aldehyde with at least one primary amine, where the reaction product includes
5 substantially bimolecular amine-aldehyde adducts.

1 41. The method of claim 40, wherein the composition includes a sufficient amount of diamine
2 to substantially eliminate aldehyde liberation upon heating.

1 42. The method of claim 41, wherein the sulfur scavenging or converting composition further
2 comprising a solvent.

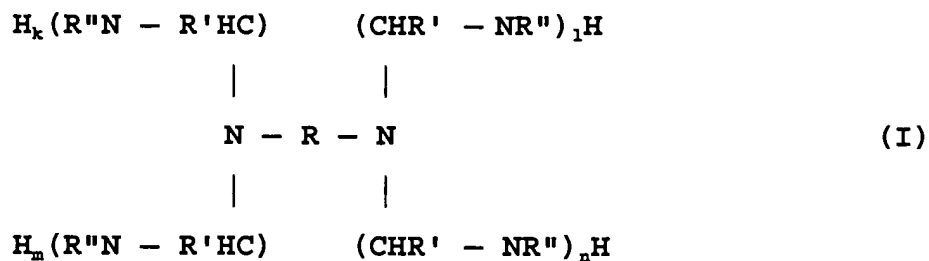
1 43. The method of claim 40, wherein the fluid or stream is associated with oil/gas field
2 equipment, a refinery, an industrial facility or an waste management facility.

1 44. The method of claim 40, wherein the oil/gas field equipment are selected from the group
2 consisting of a flowline, a separator, a tank, a line heater, a heater treater, and similar gas/oil
3 handling processing equipment.

1 45. A sulfur scavenging composition comprising a diamine terminated reaction product of at
2 least one aldehyde with at least one primary amine, where the reaction product includes substantially
3 bimolecular amine-aldehyde adducts, where a sufficient amount of diamine is used to substantially
4 eliminate aldehyde liberation upon heating and where the reaction product is substantially free of
5 higher aldehyde-amine adducts.

1 46. The composition of claim 45, wherein the higher aldehyde-amine adducts are selected from
2 the dimers, trimers, triazines and mixtures thereof.

1 47. A composition for converting noxious sulfur species to high molecular weight sulfur species
2 comprising at least one compound of formula (I):



where R is an alkenyl group, cycloalkenyl or arenyl group having between about 1 and about 20 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties and/or nitrogen atoms can be in the form of tertiary amine or amide moieties, R' and R'' are the same or different carbon-containing groups having between about 1 and about 20 carbon atoms, where one or more of the carbon atoms can be oxygen atoms in the form of carboxy, hydroxy and/or ether moieties or nitrogen atoms in the form of tertiary amine and/or nitrogen-containing groups in the form of amide moieties and where k, l, m and n are integers having a value between 0 and 2, provided that at least one has a value of 1 or 2 and where a sufficient amount of diamine is used to substantially eliminate the liberation of aldehyde upon heating and the composition includes substantially no higher aldehyde-amine adducts.